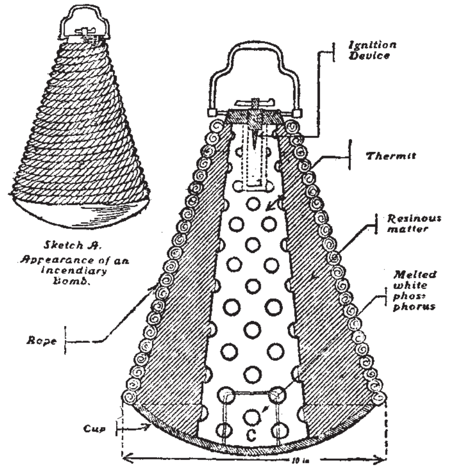
when concentrated. As they are now being sent to France daily in very large numbers it is to be hoped that the directions of the War Office recently issued will be attended to and no more respirators of other types, either home made or manufactured without official sanction, will be sent to the Front.

It must not be forgotten, however, that the efficiency of all these contrivances is limited, and in the event of being exposed to several successive doses of gas the material ought to be washed in clean water and then recharged with the original chemical mixture. A supply of liquid is now furnished to the men in the trenches.

A question has arisen in connection with the idea of the possible use by the enemy of bombs containing poison, to be dropped by Zeppelins or other aircraft. In the event of such occurrence the best course would be in the first instance to close all the windows and doors of houses in the neighbourhood. Should the smell of chlorine be perceived indoors, a cloth wetted with strong solution of ammonia should be waved about in the air. This would produce a harmless white smoke consisting of sal-ammoniac, and this, even with excess of ammonia, would produce very little if any damage to furniture, etc. With regard to wounds produced by shrapnel or other projectiles containing phosphorus, it is improbable that any of the element would escape combustion in the air. The mischief is caused by the phosphoric acid produced being carried into the tissues, and for this dressings made slightly alkaline with carbonate of soda should be used till all acid has been removed.



SECTION OF INCENDIARY BOMB.

(*a*) The bomb, as a rule, is conical, of 10 in. diameter at the base, corded round, and has a metal handle at the apex (see A). (*b*) The base is a flat cup, on to which a pierced metal funnel is fitted, having the ignition device and handle fitted at the top. (*c*) The funnel is generally filled with Thermit, which upon ignition generates intense heat, and by the time of the concussion has taken the form of molten metal of the extraordinary high temperature of over 5000° F. The molten metal is spread by the concussion. (*d*) Outside the funnel is a padding of a highly inflammable or resinous material bound on with an inflammable form of rope. The resinous material creates a pungent smoke. (*e*) There is generally some melted white phosphorus in the bottom of the cap, which develops nauseous fumes. (*f*) In some cases celluloid chippings are added and occasionally a small quantity of petrol.

The chief result of air raids so far has been the production of fires, and a timely warning has been issued by the British Fire Prevention Committee. As the committee points out, fires are not usually caused by the ordinary explosive bomb. When fire occurs it is due to open lights or fires in the house or to broken gas or electric mains. The incendiary bomb is, however, designed to produce a fierce fire in itself. The accompanying diagram shows the construction of one of the ordinary types of these missiles.

The fumes from such bombs contain a large quantity of phosphoric acid, and when inhaled produce violent coughing, but fortunately they would be completely stopped by a wet cloth. Thermit, in its ignition, produces such a high temperature that the timbers of a house would be certainly inflamed if struck, but when the first burst of flame is over the extension of the fire would proceed in the manner of fires originating otherwise and would have to be dealt with by the fire brigade in the usual way. In the meantime, every house in a threatened area should be furnished with buckets and baths full of water ready drawn to be applied as quickly as possible, in quantity as large as possible, in case of necessity.

W. A. Tilden.

VISIBILITY.

The factors which determine the ability of the eye to distinguish an object from its background are not very well known for many of the conditions met with in practice. Our practical experience has taught us that if we wish to see properly under any given condition, the illumination must not be less than a certain amount, and we have been content to provide the necessary illumination without having any very clear idea what are the aids and hindrances to good seeing. A discussion on some aspects of the subject of visibility was initiated at the Illuminating Engineering Society, on April 27, by Messrs. Paterson and Dudding, of the National Physical Laboratory; and many speakers made interesting contributions to it.

Several fields of investigation disclose themselves in connection with the subject, and are mainly concerned with cases in which objects become difficult of discernment. For instance, the conditions required to render troops or other objects invisible to the enemy is a matter which at first sight may appear simple, but if all that is said is true, the problem is a complicated one, and would justify thorough research into it.

It has been stated that if a donkey and a zebra are located in a distant field (and remained there to be observed) the zebra would become invisible long before the donkey. This effect was discussed in an interesting article by Col. F. N. Maude in *Land and Water* for January 30, in which he gave an incident from practical experience of a regiment with pipeclayed belts and accoutrements being invisible by the side of another regiment which had equipment of a more uniform nature.

The question of the visibility of distant faint sources of light at night is the simplest form in which the problem presents itself, because first, the contrast between the light and its background

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is very great, and secondly, because the object viewed is below the resolving power of the eye (about one minute of arc), and therefore the dimensions of the object viewed have not to be considered. The visibility of such point sources of light is inversely proportional to the square of the distance of the observer from them, and directly proportional to their candle-powers. Their visibility becomes an important matter at sea, since the navigation of ships so as to avoid collision depends almost entirely on them. A practical working visibility is 1·6 candles at two sea miles, whether the light be red, green, or yellow. There is a very marked difference, however, in the relative behaviour of these lights to oblique vision. To normal people a green light will appear some five times brighter when viewed obliquely than when viewed directly, but a red light acts in exactly the opposite way. If we place a point source of green light in a dark room so that its visibility from the position viewed is equivalent to about 0·01 micro-candle at a metre, most observers will pick up this light when looking in some other direction and be quite conscious of its presence, but no sooner does one look towards it than it is gone. A faint red light, on the other hand, cannot be picked up by oblique vision at all, but when an observer has finally discovered it by direct vision he is impressed by how very visible it is. If he glances to one side, however, it disappears. The colour of faint lights is not distinguishable by oblique vision.

Under favourable laboratory conditions of threshold visibility it is calculated that the energy which is just sufficient to stimulate a single element of the retina of the dark adapted eye is at the rate of about 10^{-15} watt.

The question of the visibility at night of objects of finite size is not so simple. The problem occurs in a practical form in the showing-up of an obstacle by a motor headlight, such, for instance, as a pedestrian on the road ahead of a car. Such objects subtend angles well above that of the resolving power of the eye, and there is no justification for assuming that their visibility follows the same simple laws which hold for point sources of light. The experiments show in effect that the visibility of objects subtending angles up to about ten minutes of arc follows the same law as for point sources, viz., the brightness must be inversely proportional to the square of the distance, but that for objects above this the brightness is proportional simply to the distance. It is the larger size of objects which have generally to be discerned when driving at night, and it therefore follows that for equal visibility at twice the distance the equivalent candle-power of a headlight must be increased eight times, and not sixteen times, as would be the case if the inverse square law held. Thus it follows that the useful range of a motor headlight is proportional to the cube root of the intensity of the beam.

The visibility of objects viewed in the presence of glaring lights is a matter which has been much discussed, but the reason for the discomfort and annoyance which is felt when one has a light in one's eyes is rather obscure—except in such gross cases as the dazzle produced on the dark adapted eye by motor headlights. Experiments show that at ordinary illuminations it is very difficult to detect by measurement any diminution of ability to see detail in the presence of bright lateral lights, although there is little doubt about the discomfort caused by them. When, however, the surface brightness of the objects to be distinguished is very low there is, when lateral lights are present near to the object, a marked falling off in the ability of the eye to distinguish the slight contrasts which exist over such surfaces, and detail appears in consequence obliterated. A room viewed under these conditions might have to the eye somewhat the appearance of an under-exposed negative in which only the high lights and strong contrasts show up. It cannot be said, however, with certainty that herein lies the evil of glaring lights, and the discomfort experienced with them may very well be psychological in character.

The discrimination of detail in certain circumstances depends almost entirely either on shadow or on the direction of the incident light. Where the surface of an object to be viewed is uneven, but uniform in colour, the only way in which the unevenness can be shown up is by differences in the illumination of such surfaces caused by the different angles which they present to the incident light. If the unevennesses are very deep they will be shown up by the shadows which are thrown by the raised portions on to the surrounding surfaces. For instance, the embossed lettering used on some notepaper depends entirely on this action, and a sculpture in bas-relief must obviously present a very different appearance according as it is illuminated by unidirectional light at glancing incidence or by light from a large source striking it mainly at normal incidence.

The question has a wide practical application in the manipulation of self-toned fabrics, viz., unicoloured fabrics with no natural contrasts. A person doing needlework with such materials depends for the discrimination of the detailed strands of the fabric on the small shadows cast by one strand on to the next and on the varying brightness over the curved surfaces of each individual strand. Both these factors depend on the unidirectional character of the light incident on the material, and the inefficiency of thoroughly diffused, viz., indirect light, for such work is most marked. The writer has, for ten years, used indirect lighting for domestic use, and for a long time ridiculed the assertion which was often made that it was a most unsatisfactory light by which to do needlework, and particularly darning. After experiment, however, it is clear that the contention is sound, and that there is nothing so good as a unidirectional light giving harsh shadows for the discrimination of detail in needlework of all kinds. Indirect lighting, with its soft shadows, is an ideal light for domestic use, except in respect of this one particular.

C. C. Paterson.

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